

***Emergency
and Abnormal Situations
in Aviation Symposium***

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Responding to Emergencies and Abnormal Situations

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Introduction





Emergencies and Abnormal Situations

Overview

1 Conference Challenge

- Alternative Perspectives
- Identify and Challenge Assumptions
- Challenge Conventional Training Wisdom

1 4 Topics

- Emergency & Non-Normal Events
- Non-Normal Checklists
- Human Factors / Human Performance
- Solutions

1 Pilot Expertise

1 Training Themes and Issues



Emergencies and Abnormal Situations

Preliminaries

Events

- Emergencies – very rare
- Non-normal events – rare
- “Abnormal” situations – common
 - » Unexpected departures from the norm

1 Reflexive Questions

- What exactly is being managed ?
 - How best can this be done ?
 - Are we looking at the right things ?
- 

Emergencies and Abnormal Situations

Preliminaries

Checklists

- Subtle changes over time**
- Implicit assumptions**
 - » Pilot function – and functioning**
 - » Cockpit management**
- 1 Not just “lists” + “check”**
 - » Sources of aid and confusion**
 - » Subtle shaping of pilot behaviour**
 - v Airline specific simulator practices**





Emergencies and Abnormal Situations

Preliminaries

Human Factors/Performance Issues

- 1 Perfect engine shutdown drill**
 - Wrong engine
 - 1 Good Drills + Leisurely Preparation**
 - Undesired Outcome
 - 1 Poor Cockpit Management**
 - Confusion & coordination breakdowns
 - Ambiguity and absence of focus
 - Departures from the norm
- 

Emergencies and Abnormal Situations

Preliminaries

Solutions

- 1 The Conventional Wisdom**
 - More / Better Training – what exactly ?
- 1 Experience**
 - What part of “Experience” ?
- 1 Better Checklists**
 - Design ?
 - Content ?
- 1 Problematic**





***Developing The
Four Themes***



Emergencies and Abnormal Situations

1. Events

- 1 Low Frequency of Events**
 - Reliability / Automation / Technology
 - Low exposure
 - » reduced co-pilot apprenticeship

 - 1 Unexpected events / variations – common**
 - Unexpected issues and variants
 - Real world presentation of problems
 - Real world demands and problem management
 - Real world inhibitors of performance

 - 1 Real world : simulator rituals**
- 

Emergencies and Abnormal Situations

2. Checklist Development

1 Exemplar: Cockpit Electrical Smoke

– B707 Checklist (1960's)

- » 5 detailed - technical – “flow logic” pages
- » “Isolation” trouble-shooting

1 Assumptions & Emphasis

- » Pilots will / should “trouble-shoot”
- » Checklist - a list - a *technical* document

1 Cockpit management: independent skill-set

- » Somebody is flying the aircraft
 - » Taken for granted
- 

Emergencies and Abnormal Situations

2. Checklist Development

1 Exemplar: Cockpit Electrical Smoke

- **Original B737 Checklist (1970's)**

- » 2 QRH Pages

- » Simplified “Isolation” format: some reasoning

1 Assumptions

- » Limited “trouble shooting” required

- » Checklist: isolate the source at a global level

- » Cockpit management: some notes / guidance



Emergencies and Abnormal Situations

2. Checklist Development

1 Exemplar: Cockpit Electrical Smoke

– B737 Checklist (post-1970's)

- » 1 QRH Page
- » Minimal switching – design feature
- » Systemic “Isolation” format – stop the smoke

1 Assumptions

- » Minimal “trouble shooting” – observation
 - » Checklist directed: isolate the source
 - » Cockpit management: “**Land ASAP**”
- 

Emergencies and Abnormal Situations

3. Human Factors Issues

1 Wrong engine shutdown “perfectly”

- Less common
- Still occurs in simulator
 - Inexperienced pilots or rushing / confusion
- Crew co-ordination
- Stress
- Perception of time pressure



Emergencies and Abnormal Situations

3. Human Factors Issues

1 First Identify the problem

- Where does it say this ?**
- Fly the aircraft**
 - » Self evident ?
- Crew agreement**
 - » Clear task allocation
 - » Crew co-ordination



Emergencies and Abnormal Situations

3. Human Factors Issues

1 Good Drills and Preparation

1 Poor Outcomes

- Loss of global picture
 - UAL Portland Oregon
 - SR 111
- Sometimes time is important
 - Ordering priorities

1 CRM a key factor

- Important ... but ...
 - CRM may be over-privileged
- 



Emergencies and Abnormal Situations

3. Human Factors Issues

1 Poor Cockpit Management

- Cockpit confusion**
 - Increased errors and risk exposure**
 - CRM**
 - A means, a process – not the solution**
 - CRM not an end in itself: task specific deployment**
 - Poor CRM can be a symptom**
- 

Emergencies and Abnormal Situations

3. Human Factors Issues

1 The Target

- **Good Cockpit / Error Management**

1 Causes of poor cockpit management?

- **Confusing Causes and Symptoms**

- » **Workload**
 - » **CRM**
 - » **Decision-making,**
 - » **Crew co-ordination breakdowns**
 - » **Etc. ...**
- 

Emergencies and Abnormal Situations

4. Solutions

1 Training

- What kind, what content, when, how ... ?
- “Bang for the Training Buck”

1 Experience

- What is it ?
- More than hours ... than mere “exposure”

1 Checklist Design / Content

- *Technical Issues*: Securing, configuring, ...
 - *Cockpit Actions*: Support, aiding, ...
 - *Cockpit Management*: Structuring, ordering, ...
- 

Emergencies and Abnormal Situations

Summary

- 1 Checklists are changing**
 - Underlying philosophies often undocumented
 - Transition and orientation changes 707 à 737
 - Less and less pilot reasoning
 - More operational hints / refs in checklists
- 1 Basic Human Factors**
 - Some issues not clearly addressed
 - CRM not a “catch all” HF solution
- 1 It is not entirely clear what we need to train**





***Expertise, Skills, Habits
and Repertoires***



Emergencies and Abnormal Situations

Expertise

- 1 Expertise is Domain-specific**
 - 1 Expert Knowledge & Skills**
 - Highly organised and structured
 - Distinction between experts and novices
 - » Distinguishing noise from signal
 - *Accessible, functional and efficient*
 - 1 Expert : Novice differences**
 - Applied vv abstract knowledge
 - Source of findings & training insights
 - Problem of access
- 

Emergencies and Abnormal Situations

Expertise

- 1 **Domain experts and real tasks**
 - Importance of practical skills
 - Heuristics, rules of thumb
 - Habitual, patterned behaviours
 - » Invariably undocumented: individualised
 - 1 **Domain expertise**
 - Domain specific knowledge, Implementation skills
 - Mental models, Scripts, Scenarios, Schemas ...
 - 1 **Linking of *knowledge-concepts-action***
 - Implies key training elements – what is *done*
 - Formal task analysis - operational practice analysis
- 

Emergencies and Abnormal Situations

1 Operational Management of Events

- Fly the Aircraft
 - Complete Technical Drills
 - » Assess Consequences
 - » Coordinate activity
 - Adhere to Procedures
 - Apply CRM Principles
 - Communications (multiple)
 - Decide + Implement a Plan
 - » Competing layers of activity
 - » Manage Time / Task stress, etc., etc
 - Context : Weather, Aircraft, Airfield, etc.
- 

Core Operational Skills

Basic Flying Skills



Basic Operational Skills



Operational Management Skills

***Core Operational
Skills***

Observable

Specifiable

Core Operational Skills

This is where we see the symptoms of cockpit management problems: workload, breakdowns in communications, coordination, CRM, etc. etc. ...

Core Operational Skills

Basic Flying Skills



Basic Operational Skills



Operational Management Skills

High Level Operational Skills

Unobservable

“Inaccessible”

Core Operational Skills

Basic Flying Skills



Basic Operational Skills



Operational Management Skills

High Level Operational Skills

Strategic Management Skills

Strategic Management Skills

- **Recognition**
- **Prioritisation**
- **Anticipation**
- **Projection**
- **Planning**

Core Operational Skills

Basic Flying Skills



Basic Operational Skills



Operational Management Skills

High Level Operational Skills

Strategic Management Skills



Implementation Skills and Repertoires

Implementation Skills and Repertoires

- Mental Flight Path Control
- Rules of Thumb
- Gates and Triggers
- **Event Flow Patterns**
- **Generic Response Patterns**
- Situational Concepts
- Time Management

**Basic
Flying
Skills**



**Basic
Operational
Skills**

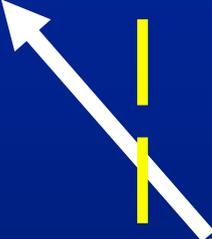


**Cockpit
Organisational
Skills**

- **Prioritisation**
- **Anticipation**
- **Planning**
- **Recognition**



- Implementation Skills
and Repertoires**
-
- **Mental Flight Path Control**
 - **Rules of Thumb**
 - **Gates and Triggers**
 - **Event Flow Patterns**
 - **Generic Response Patterns**
 - **Situational Concepts**
 - **Time Management**



Reactive Operational Skills (Novices)

Proactive Operational Skills (Experts)

Basic Flying Skills

Strategic Management Skills

Basic Operational Skills

Implementation Skills and Repertoires

Operational Management Skills



Core Operational Skills

This is where problems appear

High Level Operational Skills

**This is where the “action takes place”
- this is where problems are avoided**

Core Operational Skills

High Level Operational Skills

The Domain of Reaction

The Domain of Proaction



***High Level
Operational Skills***

**This is where
we will get the
“bang for our
training buck”**



***Drawing Lessons:
Personal Experience***





Emergencies and Abnormal Situations

Issues - Events

1 Unexpected events / variations

» Two “War Stories”

- √ The unexpected Go Around
- √ The “well managed” Go Around

1 Lessons Learned

- √ What went well – and why
 - √ What went not so well – and why
- 

Emergencies and Abnormal Situations

- 1 2. **“Well managed” event**
 - Dispatch electrical problem
 - Early gear deployment
 - » Red Light
 - » ATC – “defensive call”
 - » Briefed cabin crew / passengers
 - » Briefed co-pilot for Go-around
 - Intentions, division of tasks, fuel, time ...
- 1 **Clearly in charge ... in control**



Emergencies and Abnormal Situations

- 1 Sent to holding pattern**
 - Surprised, but had briefed**
 - » Being “ahead” works!**
 - Alternate gear deployment**
 - » Clearly an indication problem**
 - Joined pattern for landing**
 - Longer than expected**
 - » Under control**
 - Post landing issues**
 - » Spoke to ATC, cabin crew, company, co-pilot**
- 

Emergencies and Abnormal Situations

1 What went well here ?

- Management was proactive**
- All anticipated issues went very well**
 - » Situation under control throughout**
- Communications**
 - » No adverse passenger problems**
 - » No cabin crew problems**
 - » Post-landing events managed quickly**
- Time & Space Created**
 - » Stress, workload, error growth prevented**





***“ Chance favours the mind
that is prepared ”***

Louis Pasteur



Emergencies and Abnormal Situations

- 1 **What went badly here ?**
 - Items not in my management “model”
 - Items conditioned by simulator rituals
 - » Alternate Gear deployment
 - » Maintained configuration
 - Failure to seek landing priority
 - Significant fuel burn
 - » Needless risk creation
 - » Layer of defence removed
- 



***“ I learned about flying from
that ”***

Title of Column in Aviation Periodical



Emergencies and Abnormal Situations

1 Source of Strategic Skills

- Prior experience**
- “Event management” model**

1 Framework for event management

- » Generic**
- » Modified for circumstances**

1 Problem areas

- » Not previously experienced**
 - » Not anticipated**
 - » Not thought about**
 - » Inappropriate flow patterns / habitual links**
- 



***“ We first make our
habits and then our
habits make us ”***

John Dryden



Emergencies and Abnormal Situations

- 1 This became a “war story”
 - 1 War stories = “hangar talk”
 - Direct learning for participants
 - Others: A means of vicarious learning
 - I told my story
 - I heard other stories
 - 1 My story helps a friend ...
 - 1 A source of learning
 - Rarely formalised
 - Applies to most job functions
- 



Generic Structure
Habitual Routines
Generic Checklist



Emergencies and Abnormal Situations

- 1 **Generic Framework & Habitual Routines**
 - 1 **Source of Help**
 - Thinking about / ordering operational issues
 - Specific Categories of non-normal event
 - 1 **Translating lessons learned into:**
 - » Training materials
 - » Enduring value
 - » A format that will form an operational bedrock
 - 1 **An example**
 - Transforming these principles into training
 - An example, one way ...
 - New trainees, prior to type transition (JAA-MCC)
- 

SYSTEMS MALFUNCTION CHECKLIST

AIRCRAFT HANDLING ASSIGN
PROBLEM IDENTIFY & X-CHECK
CREW CO-ORDINATION/TASKS ASSURE
CIRCUIT BREAKERS CHECK
OPERATIONAL CONSEQUENCES..EVALUATE

RELEVANT SYSTEM SWITCHES.....OFF

SUPPLEMENTARY ITEMS.....COMPLETE

SYSTEMS MALFUNCTION CHECKLIST

Q EVALUATE OPERATIONAL CONSEQUENCES

W Time / Fuel Constraints

W Aircraft Performance

W Airfield Performance

W Available Resources to Manage

W Communications

W ATC, Cabin Crew, Passengers, Company ...

Ø Hand flying: all real time drills



Emergencies and Abnormal Situations

1 Role

- Encourage desired operational behaviours
- Encourage good cockpit management behaviours
- Provide a generic structure
 - » for thinking about non-normal flight management
 - » for cockpit : cabin communications
 - » smoke drills, etc., etc.
- Evoke desired CRM behaviours
- Evoke consideration of external factors
- Create a shared framework / orientation

1 Assure flying basics addressed



Emergencies and Abnormal Situations

1 Complexity

- Reduced, ordered, structured**
- Action oriented framework**

1 Initial training

- Short period**
- Not mandated afterwards**
- Formalising**
 - » what has to be learned**
 - » initial point of departure**





Drawing Conclusions



Emergencies and Abnormal Situations

1 Better Pilots and Events

- possess a good operational picture**
- clear sense of how they will manage events**
 - » clear as to their objectives**
 - » clear in their communications**
 - » clear in their actions**
 - » are in charge of events : proactive control**
- Their performance looks good**

Emergencies and Abnormal Situations

- 1 Better Pilots are “cognitively primed”**
 - Generic frames/scenarios align & focus events
 - Implementation repertoires
 - Means to monitoring effective implementation
 - 1 Good performances**
 - Decisive, focused & appropriate decisions
 - Early decision making
 - 1 Avoid confusion, delay, poor decisions**
 - » Characteristic of poor crew performance
 - » Is this fundamentally a CRM issue?
- 

Emergencies and Abnormal Situations

Issues - Events

1 Impact of the “Real World”

- Interferes with our plans
- Break cycle of expectation
- Break cycle of implementation
 - Whether from the simulator
 - ... or from previous experience

1 Introduces novel elements

- Sources of distraction, of confusion, of workload ...
 - » (a) doing things
 - » (b) unexpected / unanticipated events, consequences
 - 1 Mental workload, reactive, intensive demands on mental resources

Emergencies and Abnormal Situations

- 1 Capturing Pilot Expertise**
 - A lot can be done
 - Requires research
 - Perhaps less difficult than it looks
- 1 A Practical Activity**
 - » Cognition without the theory
 - » Theoretical models
- 1 More Emphasis on Cognition**
 - Cognition and CRM



Emergencies and Abnormal Situations

- 1 **No correct or immutable answers**
 - Cannot be “definitive”
 - A source of key training insights
- 1 **Training**
 - Does not have to be in the simulator
 - Written Scenarios
 - Guidance materials
 - » hints, traps, rules of thumb, linkages ...
- 1 **Flexible thinking**
 - Training methods, training solutions





"That's all Folks!"

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